ANNEX F1

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INTRODUCTION

Music influences plant growth! That is the contention upon which our project is based. Is there a scientific basis for this claim? Intrigued, we decided to verify its validity. After considerable documentary research. we discovered a theory being developed that could explain this phenomenon.

Indeed, a theory based on harmonic resonance, developed by Joel Sternheimer, a French physicist, postulates the existence of a relation between music and living organisms

that combines notions of molecular biology and quantum physics. On one hand, there is the basic principle of the formation of proteins from a series of amino acids in living organisms[2]. On the other hand, there is quantum physics, in which light can behave like a wave or a particle; the relationship between the quantity of movement of light (p) and its wavelength (lambda) is given by (h/p=lambda), where h is Planck's constant; and, like light, matter (including amino-acids) behaves both like a wave and a particle.

Protein synthesis involves the assembly of amino-acids (aa), which may normally be considered as chemical molecules, behaving like particles on the physical level. When amino-acids assemble to form a protein, their speed is considerably reduced and they are practically immobilized by the transfer RNA (tRNA) molecules that transport them. Their physical behavior then becomes more wave-like, since their speed has become negligible. At that point, amino-acids emit what are called scale-waves (quantum-like waves emitted by amino-acids at inaudible frequencies that link two scales; that of amino acids and that of proteins.) Mathematical calculations[1] may be used to decode the scale-waves emitted by the amino-acids of a given protein, which may then be transformed into sound waves similar to those of the tempered range of music. Exposing living organisms to this 'music' inverses the situation, thereby stimulating production of the corresponding amino-acids, leading to an increase the formation of a given protein.

Previous efforts to establish a link between music and vegetal organisms have either been conducted in a non-scientific manner or have produced negative results. Since the theory we are testing is far from accepted; it is therefore a subject of current interest, and a unique opportunity for exploration,

using a rigorous scientific approach.

The initial hypothesis is the following: A series of specific musical sounds can affect the rate of synthesis of a given protein. We sought a protein of known amino-acid sequence that could have an effect on plant growth, as well as a fast-growing plant, considering the short time available to us. Thus we chose the protein peroxidase P7 and *Brassica rapa*, a fast-growing turnip plant.

EXPERIMENTS

First we determined the sound waves corresponding to the amino-acid sequence of peroxidase P7, a protein responsible for numerous *Brassica rapa* developmental factors. Then we exposed a group of *B. rapa* plants to this 'music'. We noted a significant difference in the growth of exposed plants compared with that of unexposed plants. We observed reduced growth in *B. rapa* plants that had been exposed to specific music corresponding to the peroxidase P7 amino-acid sequence.

Materials

After planting *Brassica rapa* seeds in pots of soil, the pots were randomly placed in two boxes. One box was assigned to contain the experimental group, and the other box became the control group. The identical boxes were provided with loudspeakers; however, only the loudspeaker on the experimental group box was used to emit 'music'. In order to be sure that the experimental conditions in the two boxes were the same, devices for recording temperature and humidity were installed in them. Using 'Data Studio' software, computers were programmed to automatically record data every two minutes. The initial experiment was carried out

between March 18th and April 1st 2002.

Each plant received 20ml of water every Monday, Wednesday, and Friday. The sound sequence specific for the peroxidase P7 protein was emitted for 2 min 16 sec every day from Monday through Friday; a total of 31 min 44 sec per day, for 14 consecutive days.

Plant height was measured several times at intervals of a few days. The biomass was determined at the end of the experiment by carefully uprooting the plants, cleaning them, drying them in an oven at 30°C for 25 min, and weighing them individually.

Experimental setup

The following diagram depicts how the boxes were arranged.

Results obtained

We used standard statistical procedures to analyze the results obtained, such as means plus standard deviation, each time measurements were carried out, drafting a histogram of the number of plants as a function of plant height. This data was used to draw a curve of mean height as a function of the number of days of growth. We also constructed a histogram of the number of plants as a function of the biomass.

INTERPRETATION OF RESULTS AND DISCUSSION

We noted a significant difference in height between the experimental and control plants, and drew a growth curve that revealed conclusive results. We noted that the straight lines (control and 'musical' plants) gradually separated from each other in the graph of mean plant height as a function of the number of days of growth. On the eleventh day of growth,

the mean height of plants not exposed to sound waves was 19% greater than that of the exposed plants. Therefore, the plants exposed to sound waves grew less, which we attribute to synthesis of the peroxidase protein. In addition, in the histogram representing the height of each plant in both groups at 13 days of growth, we noted that most of the plants in the experimental group were shorter than the control plants. Indeed, 31% of the control plants were around 9 or 10cm tall, whereas plants in the experimental group were between 6 and 8cm, and hardly any of them exceeded that height.

We also studied the biomass of a dozen plants in each group. Once again, we noted a difference between the two groups. First of all, the mean biomass of the control plants was 2mg greater than that of the experimental plants. In addition, the standard deviation of the biomass was larger in the 'musical' plant group than in the control group, which could indicate that they had grown in a more disorderly way than the unexposed plants. Examining the histogram of the number of plants as a function of biomass, we can clearly see that the biomasses of individual plants in the control group are generally greater than those of plants exposed to the series of sound waves. In fact, no control plant had a biomass of less than 50mg, and the biomass of 42% of them was between 60 and 70mg, whereas among the plants exposed to the 'music', only 17% had a biomass of between 60 and 70mg.

Only a few plants in both groups had a biomass greater than 70mg. In view of the preceding, we conclude that the usually lower biomass of the 'musical' plants testifies to overproduction of peroxidase P7 protein, which is responsible for their retarded growth.

CONCLUSION

Our study, which was inspired by the work of Dr. Joel Sternheimer ('Epigenetic regulation of protein synthesis'), as well as by various experiments carried out under similar conditions, began by determining the sound waves that corresponded to the amino-acid sequence of peroxidase P7, a protein responsible for numerous *Brassica rapa* development factors. By exposing this vegetal organism to that specific 'music', we observed a significant difference compared with normal growth (control group.) After only 15 days of exposure to sound waves, we were able to inhibit the growth of plants, which confirmed our initial hypothesis concerning the influence of certain wound waves on plant growth.

Our very simple experiments point the way toward more elaborate research and experimentation which could lead to important developments in the domain of the biotechnology of vegetal organisms. Who knows -- music, or rather a specific sonic environment -- could have some effect on development in humans, in whom protein synthesis is of fundamental importance.

Bibliography

BAILLARGEON, Gérald, *Probabilités et Statistique*, Éditions SMG, Québec, 2002, 493 pages.

BENSON, Harris, *Onde, Optique et physique moderne*, Éditions du Renouveau Pédagogique Inc., 2e édition, Canada, 1999, 428 pages.

HUOT, Richard et ROY, Gérard-Yvon, *Chimie Organique*, Éditions Carcajou, 2e édition, Québec, 1996, 629 pages.

(2) LEWIN, Benjamin, *Genes*, Éditions Flammarion, France, 1988, 762 pages.

MARIEB, Elaine, *Anatomie et physiologie humaines*, Éditions du Renouveau Pédagogique Inc., 2e édition, Canada, 1999, 1194 pages.

(1) STERNHEIMER, Joël, *patent application filing to European Patent Office under the title «Procédé de régulation épigénétique de la biosynthèse des protéines par résonance d'échelle»* (Method for epigenetic regulation of protein biosynthesis by scale resonance), November 1993.

BONY, Eric, *La musique et les plantes*, taken from the Internet site: <http://www.bekkoame.ne.jp/~dr.fuk/MusiquePlantesNC.html>, 5 november 2001.

BONY, Eric, *Influence de la musique sur les plantes*, taken from the Internet site: <http://sciencefrontieres.free.fr/art/stern.htm>, 5 November 2001.

STERNHEIMER, Joël, *Interactions Non-locales dans l'Expression des Gènes*, taken from the internet site: <http://www.bekkoame.ne.jp/~dr.fuk/InterNonlocF.html>, 9 November 2001.

The Amino Acids, taken from the internet site <http://www.cryst.bbk.ac.uk/PPS2/course/section2/codes.html>, 8 January 2002

Groupe d'auteurs, *Régulation Épigénétique de la Biosynthèse des Protéines Appliquée à la Culture de Tomates*, taken from the internet site: <http://www.bekkoame.ne.jp/~dr.fuk/TomateSuisseF

.html>, 1 January 2002

Groupe d'auteurs, *NCBI Sequence viewer*, taken from the internet site: http://www.ncbi.nlm.nih.gov, 14 April 2002

EXPERIMENTAL SETUP

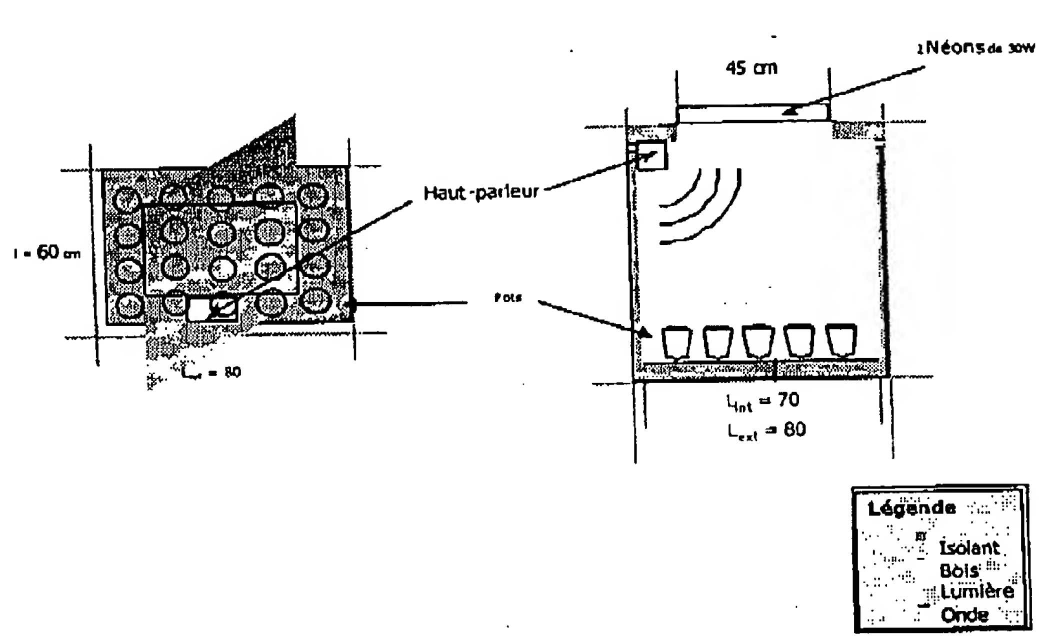
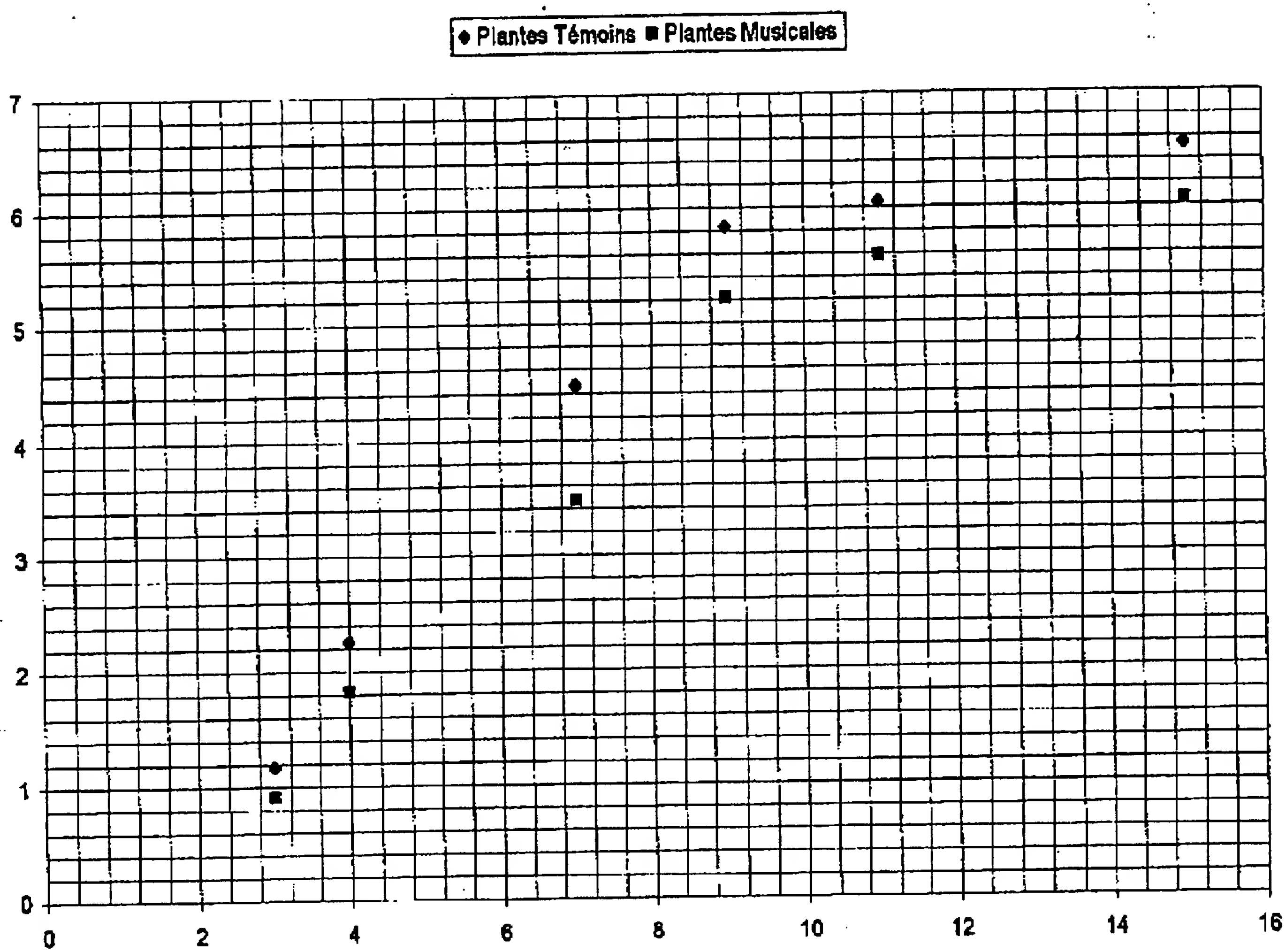


FIGURE A

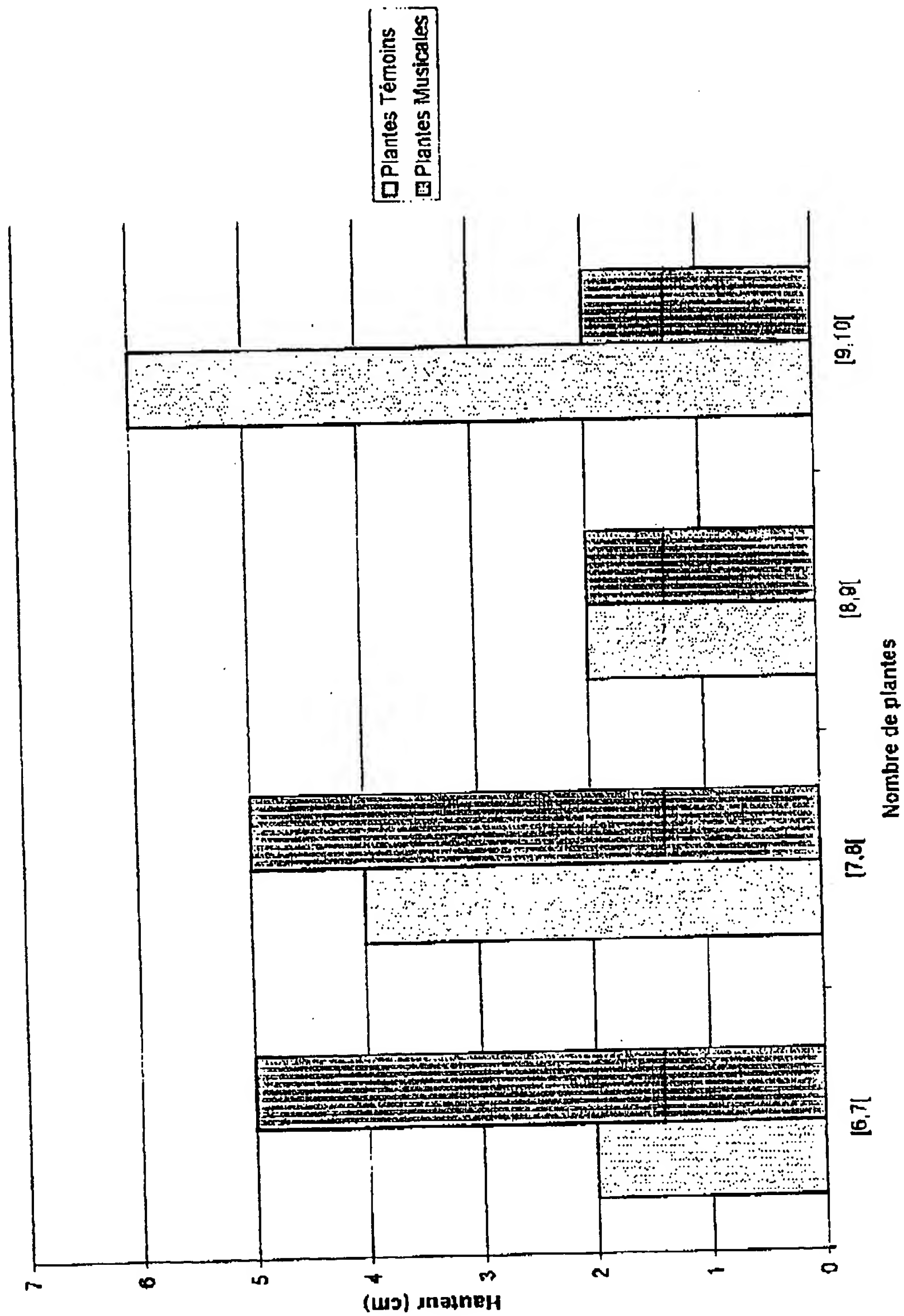
MEAN HEIGHT AS A FUNCTION OF THE NUMBER OF DAYS OF GROWTH

Fig.1 Hauteur moyenne des plantes en fonction du temps



NUMBER OF PLANTS AS A FUNCTION OF PLANT HEIGHT

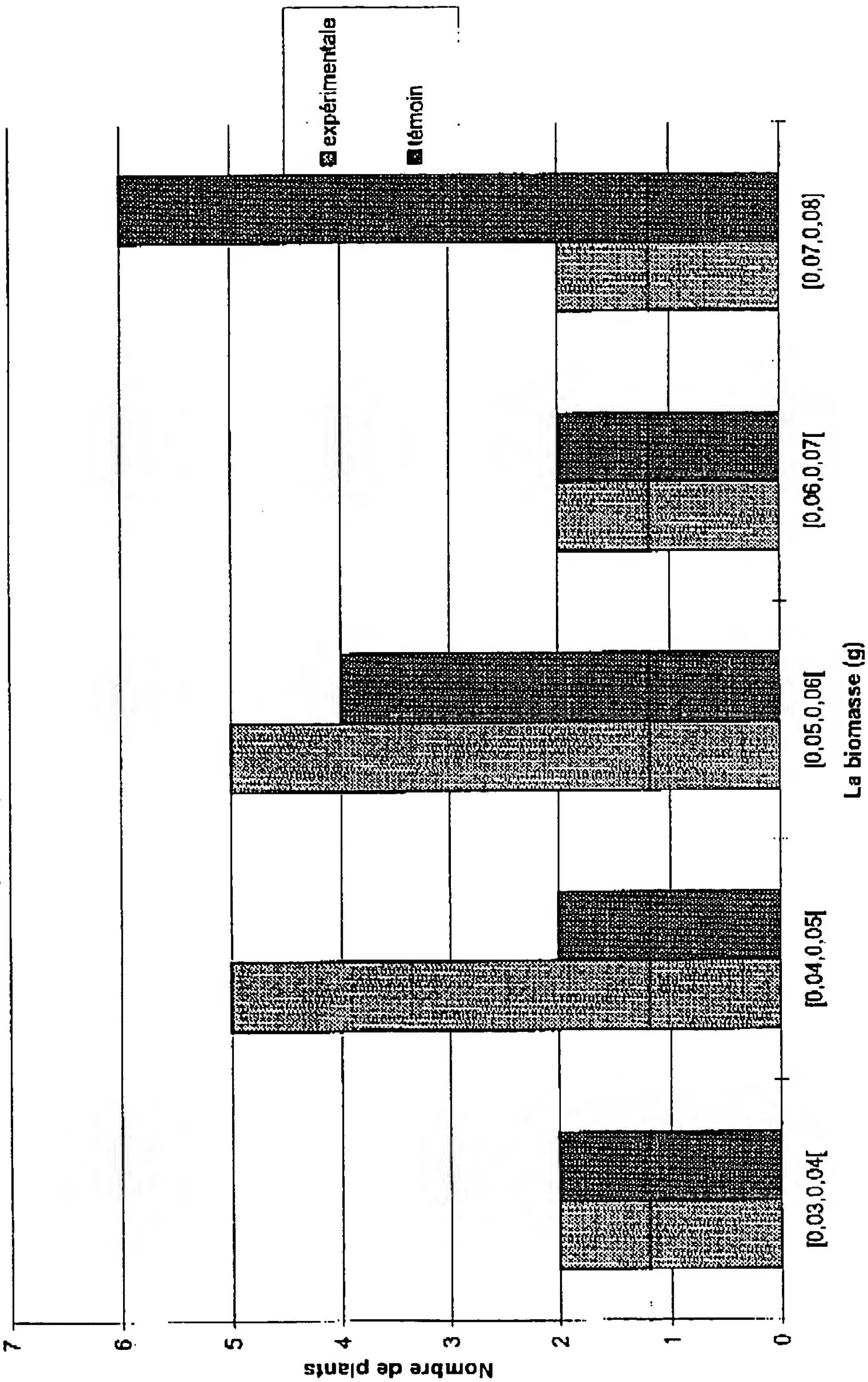
Fig.2 Nombre de plantes en fonction de la hauteur après 13 jours de pousse



graphique expérience 2

NUMBER OF PLANTS AS A FUNCTION OF THE BIOMASS

Fig.3 Le nombre de plants en fonction de la biomasse sur 12 plants de chacun des groupes après 12jours de développement



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